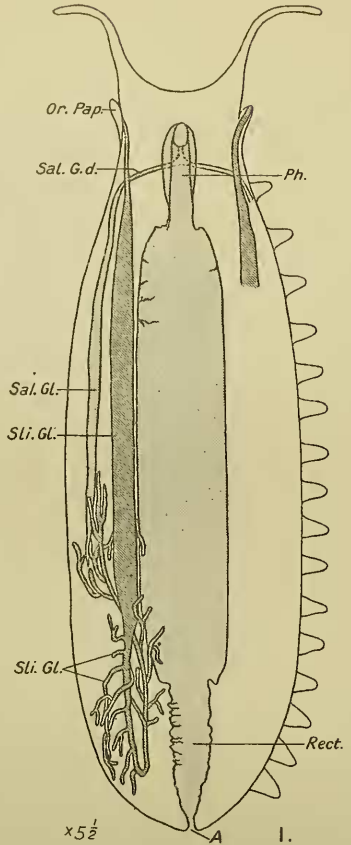
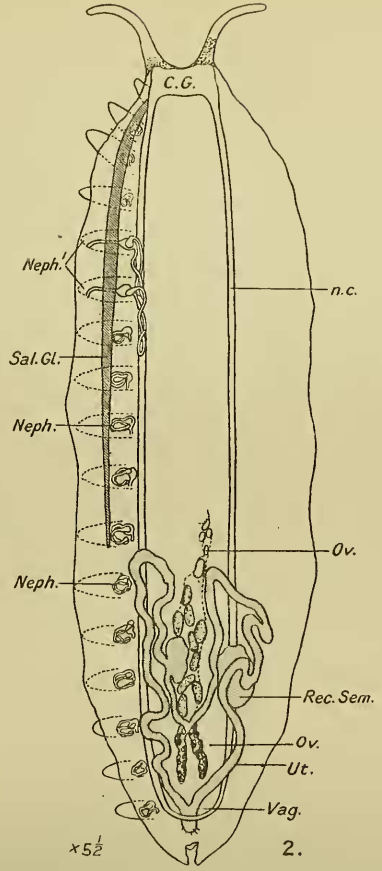
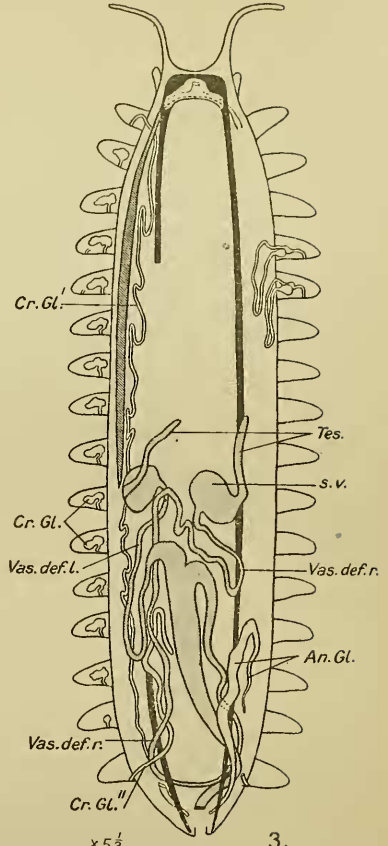


×5½ 1.



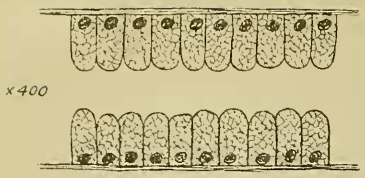
×5½ 2.



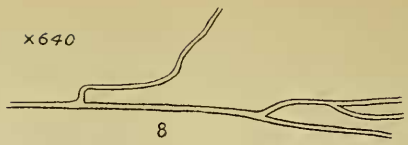
×5½ 3.

Bale & Danielsson, Ltd.

WEST AUSTRALIAN PERIPATOIDES.

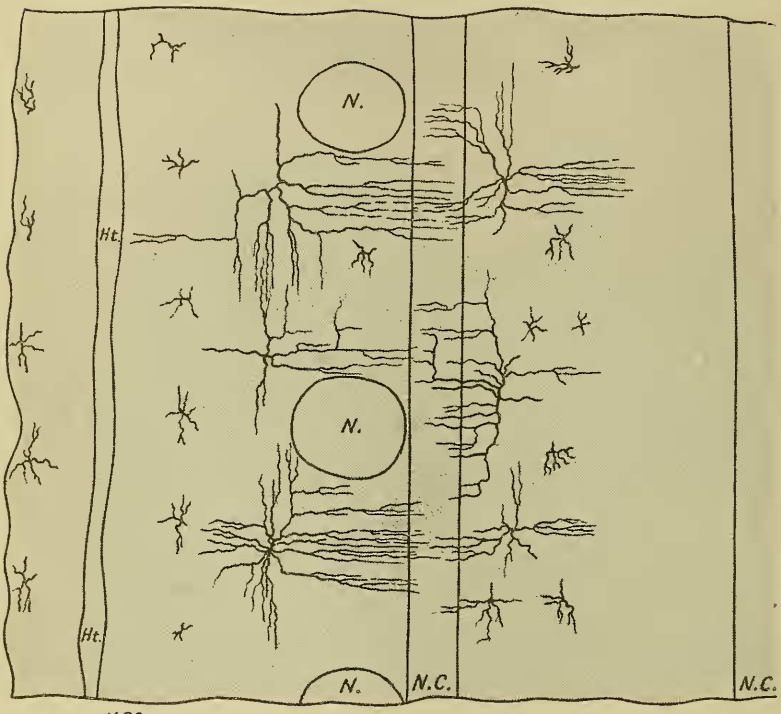


5

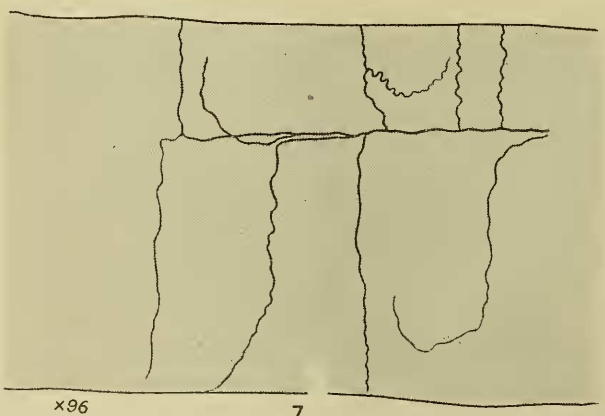


8

9



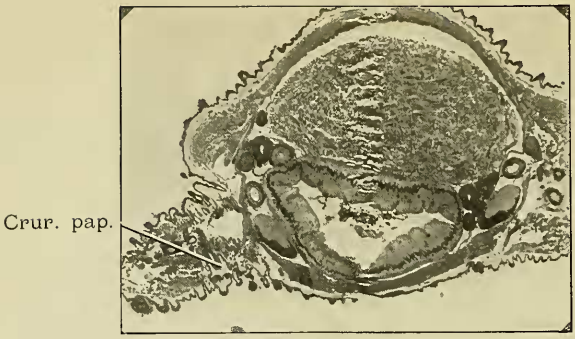
×20 6



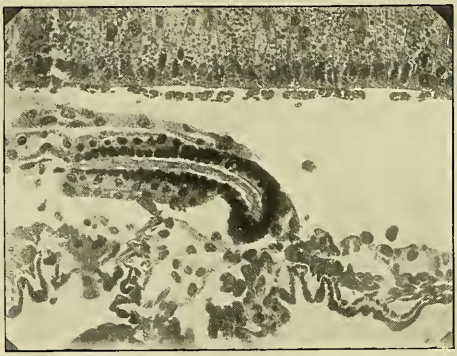
×96 7

Bale & Danielsson. Ltd

WEST AUSTRALIAN PERIPATOIDES.



4

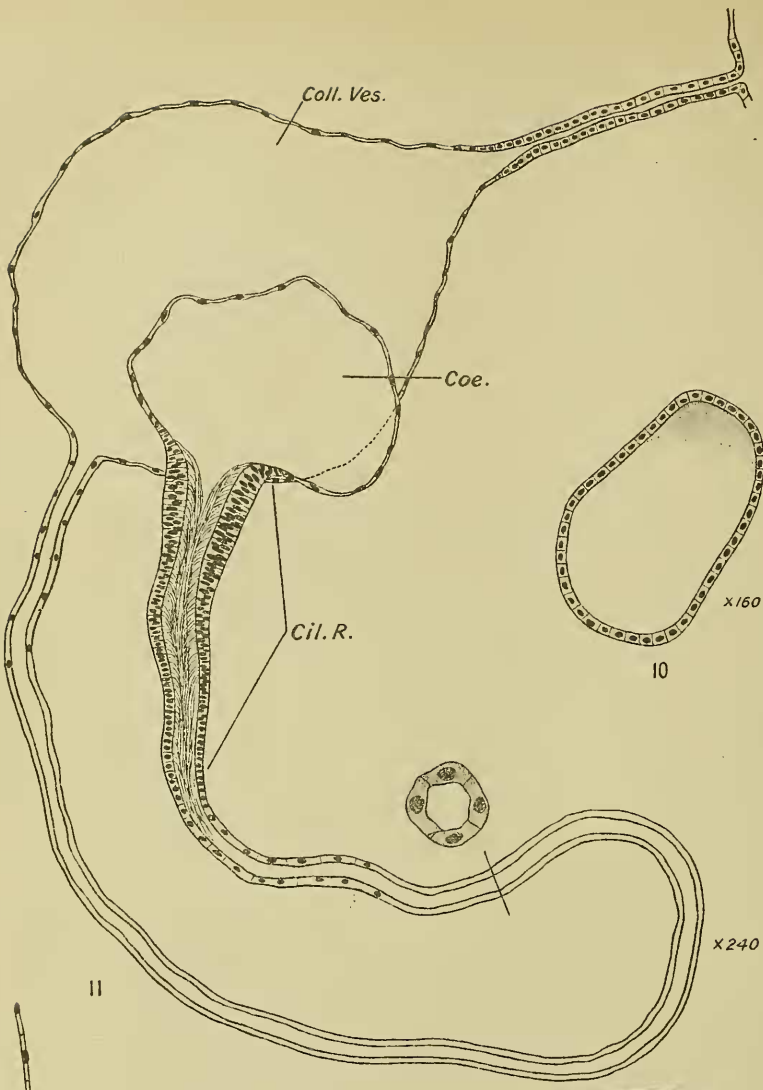


12

14

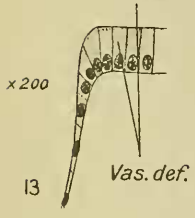
WEST AUSTRALIAN *PERIPATOIDES*.

Bale & Danielsson, Ltd.



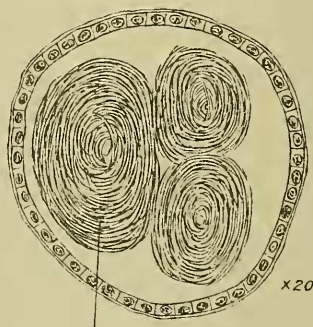
11

10



13

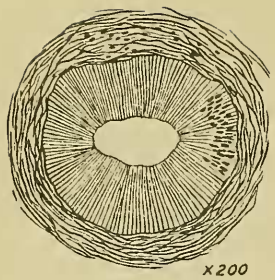
15



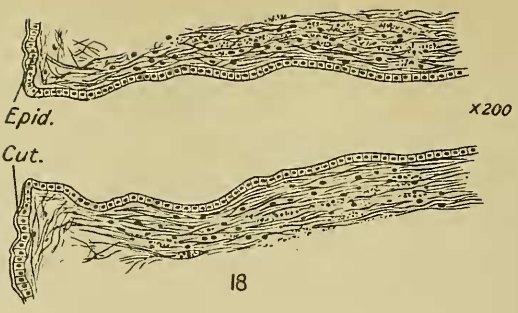
16

Bale & Danielsson, Ltd

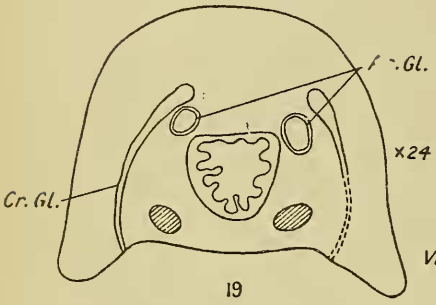
WEST AUSTRALIAN PERIPATOIDES.



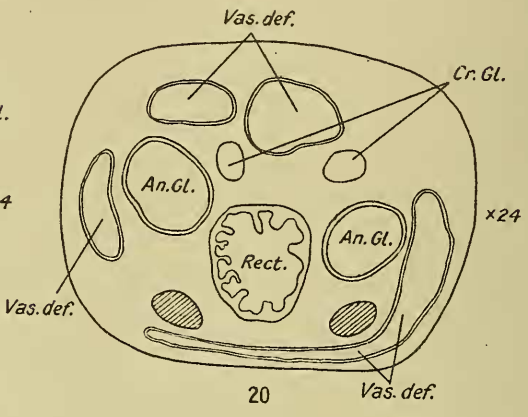
17



18

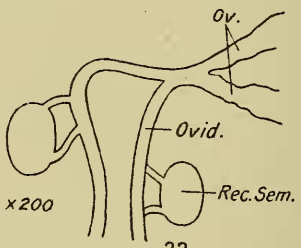


19

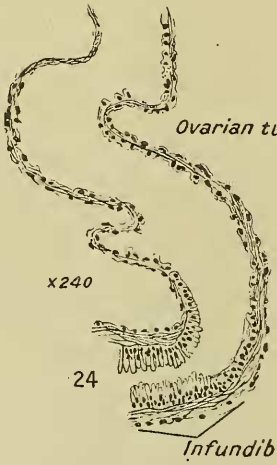


20

21

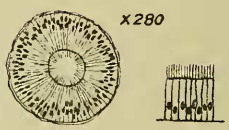


22



24

23



25

Bale & Danielsson, Ltd

WEST AUSTRALIAN PERIPATOIDES.

20. Fauna of Western Australia.—III. Further Contributions to the Study of the Onychophora. The Anatomy and Systematic Position of West Australian *Peripatoides*, with an account of certain histological details of general importance in the study of Peripatus.

By Wm. J. Dakin, D.Sc., F.Z.S., F.L.S., Professor of Biology, University of Western Australia.

[Received March 16, 1920: Read May 11, 1920.]

(Plates I.–V.*)

INTRODUCTION.

There are yet many details of interest in the structure of Peripatus which remain problematic. The histology of the eye and the structure of the tracheæ may be cited as examples; whilst even the presence of cilia, an unusual character for an arthropod, has been doubted by some histologists.

In addition to general features, such as the above, there is always the consideration that the anatomy of the different species of Peripatus should be thoroughly well known, especially as in many places there is a tendency for the advance of civilisation and closer settlement to drive this somewhat rare animal to extinction. It has been comparatively easy in Western Australia for the author to procure specimens of this interesting group of arthropods and the facilities for examining specimens being so to speak on the spot, there seemed a likelihood that a close study would reveal something new regarding the West Australian species at least. Further support was lent to this view by reason of the fact that one West Australian species, the first to be discovered, had only been collected once many years ago, and was very briefly and quite insufficiently described. Practically no details of the anatomy were known.

In all, three species of Peripatus—or, perhaps more correctly, *Peripatoides*—have been recorded from Western Australia, namely:—

1. *Peripatus leuckarti*, var. *occidentalis* Fletcher, syn. *Peripatoides occidentalis* Dendy.
2. *Peripatoides gilesii* Spencer.
3. *Peripatoides woodwardi* Bouvier.

Of these three, *Peripatoides occidentalis* was the first to be collected. It was discovered about 160 miles south of Perth, at

* For explanation of the Plates, see p. 388.

Bridgetown, by a Mr. Lea and named by Fletcher (Proc. Linn. Soc. N.S.W. 1895 (2) x.). Twelve years later, Peripatus was found in another locality much farther north, in the hills at Armadale, only about 18 miles from Perth. Specimens of these collected by Mr. H. M. Giles were sent to Professor Baldwin Spencer. He found them to belong to a new species, and in a short paper, published (**12**) in 1909, named it *P. gilesii* after the collector. Specimens of the supposed third species had been collected four years before this, *i. e.*, in 1905, by a German Expedition (The Hamburg Exped. of Michaelsen and Hartmeyer). They were also collected near Perth and in the hills. These specimens were sent to Bouvier, who wrote a detailed description of the anatomy and discussed the relationships of the species to other known Australian forms. Bouvier's paper (**3**) appeared in 1909, the same year in which Spencer's description of *P. gilesii* was published. The supposed occurrence of two species in the same district and the fact that both descriptions appeared in the same year aroused the curiosity of the present author, and the result of his investigations (see Proc. Zool. Soc. London, June 1914) confirmed his suspicions. *Peripatoides woodwardi* and *Peripatoides gilesii* turned out to be one and the same species, and since Spencer's description was published some months before Bouvier's paper, the name *P. gilesii* took precedence over *P. woodwardi*. The fullest account of the species is, however, to be found in the paper of Bouvier (**3**) under the name of *P. woodwardi*. Now, since the previous publication of the writer (Dakin, Proc. Zool. Soc. 1914), an exploration to the S.W. resulted in the collection of over 100 specimens of the Peripatus first made known from West Australia, *i. e.*, *Peripatoides occidentalis*. The consequence was that the entire question was reopened. About 100 specimens of *P. gilesii* were collected for the purpose of a detailed examination and comparison of both species, the northern and southern. The conclusion of this research was rather surprising. In all the peculiarities that marked the northern species (*P. gilesii*) the southern species agreed. The difference between the two forms was so slight that we could not regard them as more than varieties.

Thus we have reduced the number of species of *Peripatoides* in West Australia from three to one. The southern type must retain the name *Peripatoides occidentalis*—the northern form should be known as *Peripatoides occidentalis* var. *gilesii*. Further than this, however, a detailed investigation of the specimens has shown that Bouvier's description of the anatomy contains several inaccuracies, some of which are decidedly important from the point of view of comparisons. These inaccuracies are without doubt excusable, for the number of specimens at the disposal of Bouvier was small and the preservation could not have been all that was to be desired.

OCCURRENCE OF THE SPECIMENS OF PERIPATOIDES IN WEST AUSTRALIA.

It is noteworthy that all the specimens of Peripatus taken up to date have been found in the hills and at some little elevation away from the coastal plains. On the other hand they have not been found very far into the interior. They have been found in situations which, at least during the winter months, are somewhat damp but not excessively so. There is no doubt that Peripatus extends over a wide area in West Australia, but it is very difficult to map out this area, for collecting is not exactly an easy task and the animals have their usual eccentric local distribution within it. For example, the author went out on one occasion to a small valley in the hills where Peripatus was believed to occur. An entire morning was spent searching without signs of a specimen, and it was decided that after lunch a new spot should be tried further ahead—the next little valley, in fact. The next valley turned out, however, to be the one where we had imagined ourselves all the morning, and we soon found Peripatus there as on previous occasions. Here were two little valleys only ten minutes apart, with the same vegetation, the same amount of moisture, and presenting such a similar appearance that one had been mistaken for the other. Yet in the one we found many specimens of Peripatus, in the other, none.

Specimens have up to date been captured at the following places:—Lion Mill, Mundaring Weir, Armadale, Kelmscott, Kalamunda (all specimens found at these places were supposed to be *P. gilesii*), and at Jarrahdale and Bridgetown in the S.W. (*P. occidentalis*).

Most specimens have been obtained at Mundaring Weir, Armadale, and Jarrahdale. At the latter place 13 specimens were found under a small piece of branch about 1 foot square, and nearly 150 specimens were captured in three days. Very few indeed have been found under stones or under bark or fallen trees. The usual place is on the surface of the soil underneath a small or large piece of wood (a fallen branch or part of one). Here the ground is more or less damp and there is no grass. In the same situation white ants are by far the most ubiquitous creatures, with nests of true ants frequently lending variety. Large centipedes are often common, but not usually with Peripatus, which prefers, on the whole, the absence of ants, centipedes, and millipedes from its particular sheltering log.

In the summer no specimens have ever been found and this despite some very arduous work in the broiling sun. Peripatus is, however, extremely sensitive to drought, and before the dry season—November or December to April—it must find its way either below the surface of the ground or far into the crannies and cracks in fallen and decaying logs. As the breeding season coincides with the dry season it is impossible to study the

embryology of West Australian Peripatus, unless specimens are kept alive under artificial conditions in the laboratory through the long summer.

The regions in the hills where Peripatus is found are baked dry in the summer, and the temperature rises frequently to 104° F. in the shade in these valleys. The hidden recesses where protection is sought must be somewhat moist, for on several occasions the mere carriage of specimens for a few hours in a cardboard box, with none or insufficient moist earth, has resulted in the death of the animals through drying up. This is all the more noteworthy, since half-a-dozen specimens will live for days in a small glass tube. When suddenly exposed to the light of day the animals remain motionless, but after a few minutes they may move quite actively to get out of the light. Slime is often ejected from the slime glands on touching the specimen with the forceps or the finger.

EXTERNAL CHARACTERS.

Colour and Pattern.

Both the varieties of *Peripatoides* occur in two rather different colours, brown, and dark olive-green, and the numbers of each are practically equal. Between these two shades there are specimens bearing various intermediate tints, and frequently the brown specimens are so marked with dark brown (almost black) that they have quite a variegated appearance.

Closer investigation with a dissecting binocular microscope brings out the fact that the entire surface of the animal's body is covered with small papillæ. The pigment in the brown specimens is arranged as follows: There is an almost uniform brown background from which arise the papillæ above-mentioned. These papillæ are either brown (a little darker than the background) or jet black. Some of them, however, have a pale yellow area round the base. The arrangement of the papillæ is responsible for the dark patterns of the skin.

In a very dark brown specimen the effect is due to the background being much darker, the papillæ remain the same, and the pale yellow areas, as round the bases of certain black-tipped papillæ, are conspicuous. If the background is still darker—almost black—with a slight tinge of the brown in it, the effect of the black papillæ, the pale yellow areas round some of them, and the colour of the background is to produce the very dark olive-green shade of some of the specimens.

The ventral surface is more free from papillæ and the general background is an almost clear white. In the bright brown specimens, between the legs of each pair there are two patches where the background is a pale grey—a patch to either side of the middle line. On each patch there are minute black papillæ. Between each successive pair of legs the background is more or less tinged with pale orange brown and there are minute darker

orange papillæ. Each ring here bears larger and more separated papillæ which are quite white. They seem to correspond to the white areas round papillæ of the dorsal surface.

In both varieties an extremely fine light median line runs the length of the dorsal surface. It may not appear so in all specimens at a first glance. This, however, is due to the fact that in the light brown specimens, where it seems clear, it runs down the middle of a narrow band somewhat paler in colour than the rest of the dorsal surface and rather free from papillæ. In the dark specimens, on the other hand, this narrow band is darker than the rest of the dorsal surface, and with the naked eye or low power may be all that is observed. A higher magnification will show that a very fine light line runs through it medially, as in the light-coloured specimens.

The longitudinal band of the dorsal surface referred to above is related to a slight depression, the fine white line being an extremely narrow groove. The narrow band was noted by Bouvier, but the fine median white line escaped his notice.

In both varieties there are always a number of clear white papillæ between the successive legs at about the ventral margin of the flanks. These correspond, however, to the large papillæ of the dorsal surface and have merely lost the black pigment—they are identical with the large clear papillæ of the ventral surface.

The skin is thrown into a number of folds or ridges, as is usual in Peripatus. There are about 14 of these between two similar points opposite two successive legs. The ridges are to be seen both dorsally and ventrally, but are not continuous round the entire circumference of the body, for they are interrupted in the middle of the dorsal surface by the longitudinal line. But for this, however, some are continuous. Others arise between these larger folds and do not run so far. Naturally those opposite the legs are not continuous on to the ventral surface. The folds are not all of the same width, but it can hardly be said that they are alternately wide and narrow in either variety. There is really very little difference.

Oral Papillæ.

The oral papillæ are to be found in their usual position—there is nothing of particular interest to add with regard to them.

On many occasions slime was shot out from the openings of slime glands on these oral papillæ when the specimens were touched. It was emitted in large quantities when the animals were dropped on to water containing a little formalin, and also when the specimens were narcotised with chloroform.

The Cephalic Region.

Bouvier (3) has described in considerable detail the rings or ridges of the integument at the bases of the antennæ and in the

neighbourhood of the eyes. He recognises in certain Peripatus species what is termed an *ocular ring* of papillæ, with part of it differentiated to form a frontal organ. In others he states :— "l'arceau oculaire s'attenue, puis disparait assez brusquement après avoir décrit un peu plus d'un demitour, mais à ce niveau ou même bien plus en dédans, l'arceau infra-oculaire prend une remarquable prédominance, forme parfois un organe frontal et se continue par l'arceau spiral." The northern variety (Bouvier's *Peripatoides woodwardi*) is supposed to be one of the forms most typical of this group of species.

Several specimens of both varieties have been examined, and, so far as can be made out, there is no difference greater than the variations met with in either variety, between the two forms.

The Legs.

The number of legs appears to be very definite in the West Australian *Peripatoides*, and no variations are to be recorded *amongst the individuals from any one area.* There is, however, a marked difference between the two varieties which inhabit the northern and southern areas respectively.

Bouvier stated that *Peripatoides gilesii* resembled *P. suteri* and differed from all the other Australian *Peripatoides* in the possession of 16 pairs of legs. At the same time it was stated to differ from *P. suteri* in only having three pedal papillæ, in which respect it agreed with other *Peripatoides.*

Fletcher diagnosed the southern variety, *P. occidentalis*, as possessing 15 pairs of walking-legs, but no further description was given. This is the difference between our two varieties, and it is most constant. All the specimens from Mundaring, Armadale, Kelmscott, etc., in the north, have 16 pairs of legs, whatever be their size or sex. All the southern specimens bear only 15 pairs of legs. All the legs are similar with the exception of the 4th and 5th pairs in both varieties, from which one may conclude perhaps that it is one of the posterior pairs that is missing in the southern type.

Each leg is marked by rings bearing papillæ, but near the apex on the ventral surface these papillæ have united to form spinous pads, the middle one of which is somewhat wider than the others. Now in the northern variety the 4th and 5th pairs of legs differ from the others in the fact that the proximal spinous pad is segmented, a small central segment being cut off from two larger lateral lobes. This central segment takes the form of a papilla upon which the duct of the excretory organ opens. They are accurately figured by Bouvier, who remarks that the urinary papillæ of the 4th and 5th legs are always independent of the neighbouring parts of the proximal spinous pad, whereas they are always adherent in *Peripatoides suteri* and sometimes in *P. orientalis* (*P. leuckartii*). We may now add that the condition described above holds good in every detail for the southern form too.

The Mandibles.

The character of these structures has been used very considerably in systematic works, and consequently they have more than a little interest for us here.

Each mandible consists as usual of two blades. The outer blade presents a single large projection, but no small teeth. The inner blade is provided with a large principal tooth and a number of smaller accessory teeth. According to Spencer (12) there are four clearly marked and one minute accessory tooth, whilst Bouvier remarks that, as in *P. suteri*, *P. novæ zealandiæ*, and *P. occidentalis*, there are five accessory teeth. In the course of this present research the mandibles have been removed from a large number of specimens, and examined, with the result that whilst one can say that five accessory teeth are most common upon the inner blade, there may be six or even seven. In the latter case the extra teeth are very small. There is again no difference to be noted between the northern variety and the southern form previously known as *P. occidentalis*. There is never an accessory denticle at the base of the large tooth on the outer jaw blade.

External Sexual Differences and Crural Papillæ.

There is no difference in the number of legs borne by the two sexes as in *Peripatus novæ-britanniæ*, although the two sexes are to be distinguished by other characters associated with these appendages, *i. e.*, the crural papillæ. The female aperture is larger than the male aperture, as noted by Bouvier, and both apertures are found between the bases of the legs of the last pair. Behind the aperture of the reproductive organ in the male, and consequently just posterior to the last pair of appendages, are two small openings which can be recognised by their slightly tumid, pigmentless lips. These are the apertures of the anal glands.

The Crural Papillæ are the most distinctive features of the male. Unfortunately there has been some confusion as to the number present, and these structures have been taken as of considerable systematic importance. Bouvier (3) gives the following table for three males in his collection (the species formerly known as *P. woodwardi* or *P. gilesii*):—

Legs	1.	2.	3.	4	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Sp. c. Rt.	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0
Sp. c. Lft.	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0
Sp. d. Rt.	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Sp. d. Lft.	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0
Sp. t. Rt.	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0
Sp. t. Lft.	0	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0

It will be noticed that there is a very large amount of variation. Bouvier found, however, that in many cases the papillæ could be discovered by a study of the anatomy. He concluded that there was reason to believe that *Peripatoides woodwardi* possessed crural papillæ for all the legs with perhaps the exception of the *last two pairs*, although further investigation might show them to exist there too.

In making a comparison with other Australian species of *Peripatoides*, Bouvier states (relying on Fletcher's description of *P. occidentalis* (7)) that our northern variety *differs from all other Australian forms in the possession of crural papillæ on the 1st pair of legs*. In fact, this is stated to distinguish *P. woodwardi* from *all* other known species of Peripatus. This statement renders an examination of the southern variety particularly interesting.

Let us first take Bouvier's northern type. We have found that the mere presence or absence of crural papillæ when examined externally means almost nothing. Sections show *always* that the papillæ are present on certain legs but that they may be either invaginated (see Pl. III. fig. 4, Crur. pap.) or protruded. Every specimen examined has had different crural papillæ protruded. It may either depend upon the fixative or the animal may protrude certain papillæ at definite times. The preserved specimens would then indicate the condition at the time of fixation.

The fact remains, however, that crural glands are present in the male in every leg (Pl. I. fig. 3, Cr.Gl.), and papillæ are to be found on all of them too. This is a correction to Bouvier's otherwise excellent description, for he is not certain of their presence on the penultimate pair. They are rudimentary on this pair, corresponding to the condition of the crural gland, which is very small in these legs (see Pl. I. fig. 3). The papilla is well developed on the last legs, and its place is marked even when withdrawn by a minute aperture with raised lips.

It is striking to find that the above description will answer exactly for the southern form (*P. occidentalis*). Males have been obtained with almost all the appendages showing protruded crural papillæ. Sections indicate the presence of crural glands and crural papillæ exactly as they are found in the Mundaring specimens. We must emphasise in this connection the necessity for the external examination of many specimens before one can state how many crural papillæ are present. Thus we now have two varieties (of one species) which are characterised by the possession of crural papillæ on the 1st pair of limbs.*

* The above puts out of court Fletcher's description of *P. occidentalis* in which he states that the males have white papillæ on most of the legs, *but not on those of the 1st pair*.

INTERNAL ANATOMY.

Alimentary Canal, etc.

The alimentary canal presents nothing of exceptional importance in the way of differences from the conditions observed in other species of Peripatus. The jaws have already been described. A few words are necessary with regard to the muscles attached to them. It is frequently stated that the muscles of the mandibles are the only striped muscles in Peripatus. A careful examination of all the muscles in the West Australian *Peripatoides* has been made, but so far as transverse striation is concerned no differences can be made out between any of them. No muscles bear cross-stripes, all appear smooth.

Salivary Glands.

Two well-developed salivary glands are present, opening by a common duct ventrally into the mouth. The common median duct is very short (see Pl. I. fig. 1) and gives rise almost at once to two narrow tubes which run out at right angles to the long axis of the body and then bend suddenly backwards when the lateral body-wall is reached. This portion (Pl. I. fig. 1, Sal.G.d.) is non-glandular, and the walls consist of compact cubical cells. A marked change takes place when the ducts bend abruptly backwards to run in the lateral compartments in close proximity to the nerve-cord; the ducts pass here into the glandular region (Pl. I. fig. 1, Sal.Gl.) of the salivary gland. The cells of this part are often much vacuolated, and the nuclei are pushed to the bases of the cells, where they lie in close proximity to a thin muscle and connective-tissue sheath (see Pl. II. fig. 5).

The length of the salivary glands is such that they extend back to somewhere about the 7th or 8th pair of legs—that is to say, just beyond the middle of the body.

The Tracheæ.

The respiratory organs of Peripatus have always been regarded as of special note in view of the interesting relationships of the Onychophora. It is somewhat surprising, then, to find that even to-day there is some doubt as to whether a spiral fibre is present in the tracheal vessels. Other points are also uncertain.

The respiratory organs, as is well known, consist of tracheæ. These are very delicate and of minute diameter. In the West Australian *Peripatoides* they could only be made out with difficulty in preserved specimens, although more easily in sections. They are, however, exceedingly clear when freshly killed specimens are dissected under water and examined with a Zeiss binocular dissecting microscope. Ample material has rendered this mode of examination possible.

Distribution of Tracheæ.—As is well known, the tracheæ of

Peripatus arise in bunches from the bottom of little epidermal pockets which may be termed stigmata or tracheal pits. For a varying distance the delicate tracheal tubes run in a bundle all more or less parallel to each other and without branching; gradually, however, the tracheæ separate off in large or small packets from the main bundle and radiate in different directions. The tracheæ of these bundles in their turn gradually separate until they run alone. As a consequence of this arrangement and the fact that only the larger main bundles are readily visible even when filled with air, each tracheal pit appears to give rise to a little irregular rosette or star of tracheæ. That is to say, this is the appearance when the inner surface of the body-wall is examined. The arrangement is indicated in the illustration (Pl. II. fig. 6).

The tracheal pits are arranged somewhat irregularly, but mainly in the manner indicated by Balfour in 1883 in *Peripatus capensis*. There are two irregular rows dorso-laterally on each side, that is in the quadrants between the heart (Pl. II. fig. 6, Ht.) (mid-dorsal line) and each longitudinal nerve (Pl. II. fig. 6, N.C.). The more ventral series on each side appears to comprise the larger bundles. On the ventral surface there are also four longitudinal series of tracheal pits, two to each side of the mid-ventral line (only two series, those to the left of the mid-ventral line, are shown in fig. 6). The row next to the longitudinal nerve on each side appears to comprise the larger bundles. It is difficult to say how many tracheal pits there are to a segment, for the number appears to vary, and the smallest ones are not easily seen. No attempt has been made to determine the full number. Gaffron (8) states that there are about 75 per segment in *Peripatus edwardsi*. We have counted over 32 without trouble in segments of our *Peripatoides*.

There are some very large tracheal bundles in the head, supplying the large nerve ganglia. Some of the largest of these arise ventrally, and there seems to be a series of tracheal pits surrounding the mouth-opening. Just behind the mouth there is a large pit in the mid-ventral line. There are also large pits ventrally placed and in the median line in front of the mouth. Other large pits occur to the sides of the oral aperture.

Branching of the Tracheæ.—A great deal of doubt has been expressed as to the course of the tracheæ in Peripatus. Thus, in Balfour's treatise on the Anatomy and Development of *P. capensis* (1), the following statement occurs: "Moseley states that the tracheæ branch, but only exceptionally." Balfour stated that the tracheæ were "extremely minute, unbranched (so far as I could follow them) tubes." Sedgwick, in his article in the Cambridge Natural History (10), states that the tracheæ "appear to branch but only exceptionally."

Now the *main* trunks do not branch in the West Australian *Peripatoides*, but if a piece of alimentary canal-wall in the fresh state is mounted in salt solution and examined with

$\frac{1}{12}$ oil-immersion lens, branched tracheæ can easily be found (see Pl. II. figs. 7 & 8).

The nerve-cords, ganglia, alimentary canal, and in fact all the organs are well supplied with tracheæ and branching is easily discovered. But it is only when an oil-immersion lens is applied to practically living tissues that the full extent of the tracheal system becomes apparent. Pl. II. fig. 8 shows more distinctly the manner of division of the tracheal vessels.

Pl. II. fig. 7 is but a very small area of the alimentary canal-wall indicating the course taken by the branching tracheal vessels there. Attempts to follow out with certainty the fine terminations of the branched tracheæ have so far met with little success. They simply end, but whether the end has been seen or whether still finer capillary tubes continue and penetrate cells is unknown.

The Structure of the Tracheæ.—Typical insect tracheæ are elastic structures lined by an extremely delicate chitin layer which is strengthened by a spiral fibre. The spiral fibre is said to be absent from the fine capillary twigs. In large insect tracheæ the spiral thickening is easily observed with a moderately low power of the microscope. The largest tracheæ of Peripatus are, however, of minute dimensions, and it is not surprising therefore that uncertainty should have arisen as to whether they presented the spiral so characteristic of other tracheate arthropods. Balfour noticed something and was led to state that the tracheæ exhibited a faint transverse striation which he took to be indicative of a spiral fibre. No one seems to have gone beyond this since, and Sedgwick (**10**) in 1910 restated it in the description : "The tracheæ are minute tubes exhibiting a faint transverse striation which is probably the indication of a spiral fibre." Gaffron (**8**) remarks that it is questionable whether a spiral fibre exists, the only indication being some fine cross striping seen only with high powers.

This question has been solved, like certain others, through the application of the oil-immersion lens to fresh material mounted in salt solution. There is now no doubt but that the delicate tracheæ of *Peripatoides* are strengthened by an excessively minute but perfect spiral fibre (Pl. II. fig. 9).

The Crural Glands.

Reference has already been made to the crural glands in the section dealing with the external characters.

They are particularly well developed in the males, where a pair can be found for every pair of legs. With the exception of the glands of the first and last pairs of legs, which are highly modified in both the West Australian forms, the crural glands are entirely contained in the legs. The external aperture is very distinct. It is situated distally to the nephridial aperture on the ventral surface of all the legs except the 4th and 5th, where the excretory opening is found near the end of the appendage. The extremity

of the gland-duct which opens to the exterior is provided with a swollen circular lip which forms the crural papilla. The surrounding epidermis is retractile and may be invaginated to form a little *Crural Pit*. The crural papilla is then quite invisible from the exterior, but this is merely a temporary condition, and consequently there is no point in counting visible crural papillæ in these animals unless the count is checked by sections. With the exception of the last pair of glands, opening on the last pair of appendages, the aperture of the gland leads to a narrow duct bounded by small cubical cells. This duct runs upwards to open into a large vesicle which extends distally and occupies quite a large extent of the leg-cavity. The vesicle itself, *i. e.*, the crural gland proper (see Pl. IV. fig. 10) is lined by a layer of small and compact cubical epithelial cells with large nuclei centrally placed. The glands are usually readily distinguished by reason of the contents, which in sections stained with hæmatoxylin and eosin appear bright pink. Still more characteristic is the fact that the contents are perfectly homogeneous and *non-granular*.

The first pair of Crural Glands differs considerably from all the rest. The duct opens in the same manner as in the succeeding glands but instead of leading to a sac in the leg it passes into the lateral cavity of the body and opens into an elongated sac which runs almost the entire length of the animal (see Pl. I. fig. 3, Cr.Gl.'). This tubular gland can be easily picked out in transverse sections, for it is always cut transversely and lies not far from the lateral nerve-cord and below the salivary gland in sections where this is also present. The structure of its wall is quite characteristic.

These extraordinary crural glands of the first legs were discovered in the West Australian *Peripatoides* from the hills near Perth by Bouvier. They are noted in his monograph as peculiar to the species. It is important, therefore, to note that the same feature is present in the southern variety—in short, this character is peculiar to both West Australian varieties of *Peripatoides*.

The Crural Glands of the penultimate legs are extremely minute. The duct is short and leads into a very small vesicle. Bouvier was uncertain as to whether crural glands existed here at all. He was unable to find them in his specimens.

The Crural Glands of the last pair of legs are very different from all the others. The ducts pass direct from the legs into the central body-cavity, where they lead into two somewhat wide tubes which run forwards entangled in the coils of the gonoducts (see Pl. I. fig. 3, Cr.Gl.").

Crural glands and crural papillæ are features of the male sex, but in Willey's account of the Anatomy and Development of *Peripatus novæ-britanniæ* (**13**) the following reference occurs to crural glands in the female: "Wherever they occur (crural glands) they are found only in the male except in *P. capensis*, where they are said to occur in the female also (Sheldon).

Without denying their occasional existence in the female *P. capensis*, I may say that I have failed to find them present, and I doubt, on *à priori* grounds, if they normally occur in the female."

In the paper (11) to which Willey refers the following statement is made: "I have examined several legs of *P. capensis*, both of males and females, and have found a crural gland in every one except the first pair of legs."

A careful search through sections of female *Peripatoides* of Western Australia has shown that crural glands *do* occasionally occur in the female. They are not always present, however, and when found there is no regularity as to the legs containing them. In any case they are not highly developed, although they have the same vesicle with the same pink-staining homogeneous contents found in the male.

The Nephridia.

A very careful study of the nephridia of Western Australian *Peripatoides* has been made, and well-preserved sections have elucidated many points. It will be perhaps desirable to describe their structure in detail, especially since some features, the presence of cilia for example, are now made known for the first time. Mention of cilia occurs in all general descriptions of Peripatus, but only to the effect that they are found in the generative ducts. The cilia discovered in the nephridia of *Peripatoides* are remarkably well developed and of great length, reminding one more of flagella.

The nephridia, with the exception of those of the 4th and 5th pairs of legs, open on the ventral surface at the junction of each leg and the body. Those of the 4th and 5th pairs of legs are quite different from the others. They open on a special papilla situated on the ventral surface of the respective legs (see Pl. I. fig. 2, Neph.'). It is rather striking that with variations in the anatomy of the Onychophora, and in particular with considerable variations in the number of legs, there should be such a constancy in regard to the position of these special nephridia. They are of almost exactly the same form in the West Australian *Peripatoides* as in *Peripatus capensis*, and similar enlarged nephridia occur in other species.

Nephridia are found in all the pairs of legs without exception in the West Australian *Peripatoides*.

Structure of a typical Nephridium.—The aperture, which, except in the case of the 4th and 5th nephridia, is unmarked by any papilla, appears as a little crevice in the epidermis. This leads into a short tube of minute diameter. This duct passes upwards into the lateral compartment of the body and opens into a thin-walled collecting vesicle (Pl. IV. fig. 11, Coll. Ves.). The cells of the duct are small, cubical, or somewhat flattened, but the vesicle is lined by a very delicate squamous epithelium of large cells, the nuclei appearing distinctly some distance apart. The vesicle might easily be mistaken for a split in sections were it not

for its constant presence and the ducts opening into it. Following the vesicle the nephridium is divisible into two marked sections, a tubular portion and a terminal chamber. The tube describes a rough circle and then turns abruptly on itself, so that its termination is close to the vesicle referred to above (see Pl. IV. fig. 11).

The terminal chamber (Pl. IV. fig. 11, Cœ.) is now well known, although missed by the first investigators, who believed that the nephridia opened into the lateral compartment of the body. The chamber lies partly above and partly posterior to the collecting vesicle referred to above.

The first portion of the nephridial tube internal to the collecting vesicle is lined by a very delicate and characteristic epithelium of large flat cells. As a consequence of the size of the cells relative to the diameter of the duct it is possible to have transverse sections with only two or three nuclei showing (see Pl. IV. fig. 11). The greater part of the nephridium between the terminal chamber and the collecting vesicle is built in this way. The section, however, which actually opens into the terminal chamber is very different. The wall of the nephridium becomes thicker and far less delicate and is formed of a compact layer of columnar epithelial cells (see Pl. IV. fig. 11, Cil.R.). These cells are so crowded and the nuclei stain so distinctly that most previous workers have noted the peculiarity. In fact this change in the character of the cells has been taken as indicating the passage from the ectodermal part of the nephridium to the mesodermal portion (see Glen, Q. J. M. S. 1918, vol. lxiii.).

Now it is the cells of this section of the nephridium which bear the cilia (Pls. III.–IV. figs. 11 & 12). These are so long that after projecting from the cell they extend along the lumen of the duct for a relatively considerable distance. It is extraordinary that in many figures showing the structure of the nephridia of Peripatus details of the histology are given at a high magnification, yet no indication of cilia is presented.

Bundles of long cilia are very characteristic of renal cells, although at the same time they are in the highest degree peculiar for the arthropoda. The Annelid resemblances of *Peripatus* are certainly heightened as a result of the examination of well-preserved sections through the ciliated ducts of these nephridia*.

* Since writing the above I have been enabled to examine a copy of Gaffron's famous paper (8) on the Anatomy and Histology of Peripatus, in which the first mention of the presence of cilia in this animal—in the Receptacula seminis—was made. Looking through his description of the nephridia I found to my surprise the following lines referring to the region where the duct opens into the cœlomic vesicle. It must be remembered that the vesicle was unknown at the time, and its remains were supposed to be a funnel-like nephrostome opening into the body-cavity. "Er besitzt wie der Trichter selbst, kleinzelliges, im Leben *wahrscheinlich wimperndes Epithel* . . . ." Gaffron never indicates that he found cilia here nor are any shown in his illustrations of this region. We must conclude that the remark was merely a conjecture, probably suggested by the apparent resemblance to the open nephrostome of an annelid. It is curious, however, that his successors who have studied the nephridia have not commented on this. Either the cilia are only found in the West Australian *Peripatoides* or else my preparations must be particularly favourable ones.

The Nephridia of the 4th and 5th pairs of legs (Pl. I. fig. 2, Neph.'). These nephridia differ from the others firstly in the increased length of the tube between the distal collecting vesicle and the opening on the leg. This is due to the fact that the renal aperture is situated near the extremity of the appendage. The vesicle presents the same structure as before. From the collecting vesicle a long, tubular portion extends posteriorly within the lateral compartment of the body. This section presents the same type of wall as the corresponding section of the other nephridia. Having reached somewhere about the second succeeding pair of legs the tube turns on itself and runs forward, the two limbs being in close contact. The wall still presents the large flattened cells. This section passes into the ciliated duct, which is particularly well marked in these nephridia, and opens into the cœlomic chamber, which lies close to the distal collecting vesicle.

The Reproductive Organs.

A somewhat detailed description of the reproductive organs of the West Australian *Peripatoides* is rendered necessary owing to the fact that Bouvier's specimens of the northern variety were not sufficient to allow of a complete and accurate account of the anatomy. This applies in particular to the female, in which connection Bouvier states (3) "L'appareil génital femelle ne présente rien de particulier, si *ce n'est l'atrophie complète, ou à peu près complète, des receptacles séminaux.*" The receptaculum seminis is, however, well developed. The explanation of the mistake probably lies entirely in the state of preservation of the few specimens available. We have had the good fortune to obtain many specimens and to preserve them in many ways.

The Male Reproductive Organs consist first of the two testes, which lie fairly far forwards entangled amongst the diverticula of the slime glands (see Pl. I. fig. 3, Tes.) and dorsal or lateral to the alimentary canal. These organs are tubular and from the wall cells are cut off which are apparently the spermatocytes. *These do not develop into spermatozoa in the testes. Apparently the development of spermatozoa takes place in the vesicula seminalis* (see Photomicrograph, Pl. III. fig. 14).

This feature is to my mind rather interesting; yet it is one which is never mentioned in text-books. It was naturally thought at first to be quite a new discovery. As a matter of fact it was seen by Gaffron many years ago and figured in his work (8). Gaffron was struck also by the resemblance to the conditions in the earthworm and actually writes: "Etwas ähnliches findet sich bekanntlich beim Regenwurm, wo ja auch die eigentlichen Hoden den 'Samenblasen' gegenüber sehr zurücktreten und die Weiterentwicklung der Spermatozoen in letzteren stattfindet."

Each testis opens into a seminal vesicle (Pl. I. fig. 3, S.V.), one usually lying somewhat in front of the other owing to the

crowded condition of the body-cavity. It is difficult to separate the delicate ducts in preserved and consequently hardened specimens. The seminal vesicle may, however, attain such a size at a certain season of the year (September–October) as to fill up most of the body-cavity where it occurs. This is well shown in the illustration Pl. III. fig. 4, which is a photomicrograph of a transverse section passing through such a seminal vesicle. The wall of the seminal vesicle is rather delicate, being formed of somewhat flattened epithelial cells (Pl. IV. fig. 13). The vas deferens leaves the seminal vesicle at the opposite side from the entrance of the testis or testis duct. (It is impossible to divide that portion of the reproductive organs beyond the seminal vesicle into regions.)

The first portion of the vas deferens following the seminal vesicle is lined by almost cubical cells (Pl. IV. figs. 13, 15). This leads imperceptibly into a section (by far the longest) the wall of which is of flattened cells, the epithelial layer being, however, supported by a layer of longitudinal and circular muscle fibres. This section of the vas deferens coils about, entangled with its fellow of the opposite side and also with the terminal portions of the accessory reproductive glands.

What we may term the vas deferens of the right side continues its course to the left of the alimentary canal right away on towards the posterior extremity of the animal (see Pl. I. fig. 3, Vas.def.r.). Just in front of the male opening it dives under everything, even the two nerve-cords, and, reaching the right side, it continues its way anteriorly again.

This extraordinary difference from the course of the other vas deferens (Pl. I. fig. 3, Vas.def.l.) is always met with. It was indicated by Bouvier, but his drawing is not quite accurate.

Eventually, somewhere about the 4th or 5th leg from the posterior extremity, both vasa deferentia join up to form a very wide terminal unpaired tube. The first portion of this wide duct has thin walls, the epithelium consisting of flattened cells (Pl. IV. fig. 16). As the reproductive aperture is reached the walls become thicker (Pl. V. fig. 17) owing to a gradual development of transverse and longitudinal muscles. The terminal portion (Pl. V. fig. 18) is very muscular, the walls being quite thick. It is probably extrusible. This last section turns over to the right side of the alimentary canal and passing underneath the right nerve-cord reaches its opening to the exterior (see Pl. I. fig. 3).

As Bouvier pointed out, the vast chamber formed by the commencement of the unpaired duct is usually filled with a mass of spermatozoa, the whole taking the form of a convoluted cord (Pl. IV. fig. 16, Sp.). There is no sign of any chitinous envelope. It will be seen that the unpaired section of the reproductive ducts formed by the union of the two vasa deferentia is the region for the storage of spermatozoa and their massing into spermatophores—not the so-called seminal vesicle, where spermatogenesis takes place.

From the fact that sperms are found throughout the ducts of the female I have no doubt that females are impregnated through the vaginal aperture.

Accessory Ducts, etc.—The crural glands of the last legs of the male are modified as already pointed out. The minute duct, which opens in the usual place, runs into the central body-cavity and enlarges to form a thin-walled vesicle which runs forwards as far as the antepenultimate leg or thereabouts. It walls and contents (see Pl. IV. fig. 10) are similar to those of the normal crural glands of the anterior limbs.

Two other accessory glands, the anal glands, open in close proximity to the male reproductive opening, and slightly posterior to it. From each opening a narrow duct passes laterally under the nerve-cord and then turns dorsally and inwards and forwards, gradually widening until a rather wide sac is produced (Pl. I. fig. 3, An.Gl.).

These glandular sacs are rather prominent in transverse sections near the posterior end of the animal (Pl. V. figs. 19 and 20, An.Gl.), and are easily picked out by reason of the intensely vacuolated cells which form their walls. The contents, too, are very granular and deeply staining (see Pl. V. fig. 21).

The Reproductive Organs of the Female.—The ovaries of the West Australian *Peripatoides* agree with those of the other Australian forms and with the Cape and New Britain species in having thin walls, so that the developing eggs come to hang freely in the central division of the body-cavity (Pl. I. fig. 2, Ov.). From each organ an oviduct (Ovid., Pl. V. fig. 22) leads forwards for a short distance to open into a large and fully developed receptaculum seminis by two ducts (Pls. I., V. figs. 2, 22, Rec.Sem.). It is true that the receptaculum may reach a much larger size in September–November, but it is none the less a well-defined permanent structure at all times.

The oviducts, which open into the two ovaries, unite for an extremely short distance at their origin and then separate again (Pl. V. fig. 22). Their course is then amidst the convolutions of the slime-glands for a short distance to the point where each communicates with a receptaculum seminis. This first section of the oviduct is characterised by somewhat thick walls, the epithelial cells are deep and crowded together, the lumen of the duct usually appears restricted (see Pl. V. fig. 23).

As Willey noted in the case of *Peripatus novæ-britanniæ*, the walls of this first section of the oviduct differ from those of the rest of the genital duct. Willey (**13**) termed this portion the *infundibulum*, and remarked that the striking contrast between the infundibula and the ovarian tubes seen in *P. novæ-britanniæ* has not been remarked in other species.

The infundibula of the West Australian *Peripatoides* do not differ materially from those of *P. novæ-britanniæ*. So far,

however, as the ovarian tubes are concerned, I have been able to distinguish peritoneal investment, tunica muscularis, and germinal epithelium, and the thickness of the wall increases as we pass to the infundibulum (Pl. V. fig. 24). I should be inclined, on the whole, to doubt the possibility of the ovarian tubes not being strictly homologous structures throughout the genus—a suggestion of Willey's.

The receptacula seminis (Pl. V. fig. 22, Rec.Sem.) are two thin-walled bags, each of which communicates with the infundibulum of its side by two short ducts. The same condition is met with in other species of Peripatus where the receptaculum is present.

The preparations which I have at my disposal show that cilia are present in the tubes connecting the infundibulum with the receptaculum (see Pl. V. fig. 25). This is the position in which cilia were first discovered in Peripatus by Gaffron (8). It must be noted that these cilia are much shorter and less distinct than those described earlier in this paper as occurring in the nephridia.

The two uteri do not differ essentially in histological structure from the infundibula. They possess a well-developed musculature — transverse and longitudinal fibres surrounding the epithelial wall. These uteri pass forwards for a short distance and then return, usually one to each side of the alimentary canal (Pl. I. fig. 2, Ut.). They meet posteriorly quite near the external aperture, and a median and very short vagina (Pl. I. fig. 2, Vag.) leads to the exterior. During the summer months each uterus presents the appearance of a string of sausages. This is due to the chain of developing eggs or embryos contained within it. The eggs are of very large size indeed, and the uterus is swollen considerably round each and constricted between them. The West Australian examples of *Peripatoides* bring their reproductive organs to maturity during the winter, which is the only period of feeding and activity in general. Fecundation probably takes place about August to October. The species is viviparous. [For further reference see notes on Spermatogenesis and Reproduction in a following paper.]

Summary of characters diagnostic of the West Australian *Peripatoides*.

There are two West Australian varieties of Peripatus—subgen. *Peripatoides*. They agree in external characters and in anatomy, with the exception that whilst the northern form possesses *constantly* 16 pairs of legs, the southern variety has only 15 pairs. It is not considered advisable to separate these two forms as distinct species. They can only be considered varieties. The first to be discovered and named was the southern variety, which was termed *Peripatus leuckarti* Säng., var. *occidentalis*, by Fletcher in 1895.

Since that date, however, this western form has been raised to

specific rank by Dendy (5), and is now recorded as *Peripatoides occidentalis*. The rediscovery of the typical form and the demonstration that its anatomy is almost identical with that of the other form which Bouvier recognised as quite distinct from all other Australian *Peripatoides* endorses Dendy's action. The northern variety was termed *P. woodwardi* by Bouvier, but we have shown (4) that this name lacks priority, the name *P. gilesii* having been previously given by Baldwin Spencer. The position is, therefore, that the only West Australian species of *Peripatoides* is *Peripatoides occidentalis*, the southern form being the original one named, the northern is thus to be known in future as *P. occidentalis* var. *gilesii*.

Previous diagnoses of *P. occidentalis* are to a large extent incorrect.

The Diagnosis of the Species is as follows :—

(1) Specimens fall into two colour series, in one of which dark green-black predominates, in the other a brown-red. (2) The legs number 16 pairs in the var. *gilesii*, 15 in the typical form. (3) The third pedal ring (or spinous pad) is usually slightly narrower than the first, and the intermediate ring a little larger than in the other *Peripatoides*; the rudiments of the 4th ring are practically invisible. (4) There are no accessory teeth on the outer blade of the mandible, and 5 or 3 on the inner blade. (5) The urinary papillæ of the 4th and 5th legs are each on a separate segment of the first pedal ring. (6) The crural papillæ are present on all the legs of the male, but may not be obvious owing to retraction. (7) Crural glands are present opening on all the legs; those of the 1st pair are very long and extend almost the entire length of the body in the lateral compartments. Those of the last pair of legs are also long and run forwards entangled with the reproductive ducts in the central body-cavity. All the other crural glands are contained in the legs. Those of the pair of legs preceding the last are very small. (8) The male reproductive organs may extend forwards as far as the 6th or 7th pair of legs from the posterior extremity. The two vasa deferentia after leaving the vesiculæ seminales in which spermatogenesis takes place run a tangled course. That of the right side runs almost to the extreme posterior end and to the left side of the body, it then curves under both nerve-cords and runs forward on the right side to meet its fellow and form an unpaired duct at about the level of the 4th or 5th pair of legs from the posterior end. The proximal portion of this duct is very wide and very thin-walled and forms a reservoir where spermatozoa accumulate in tangled "cordons." It passes gradually into a short muscular ejaculatory duct. (9) The ovaries are dorsal in position and extend forwards from near the posterior end, occupying the hinder third of the body at the breeding-season. The walls of the ovaries are thin, and the eggs when ripe appear

in consequence to lie freely in the central cavity of the body—in reality the ovary-wall projects in the form of very delicate follicles. (10) Receptacula seminis are present, each communicating with the oviduct of its side by two ducts which are ciliated.

AFFINITIES OF THE WEST AUSTRALIAN PERIPATOIDES.

Bouvier discusses at some length the affinities of his *Peripatoides woodwardi*. His account requires bringing up to date owing to the corrections necessary by reason, first, of the increased knowledge of this northern variety, and, second, owing to the information now brought forward regarding the anatomy of the southern form known to Bouvier as a distinct species. According to Bouvier the West Australian Peripatus is remarkable for its multiple affinities. It is supposed to resemble *P. suteri* of New Zealand by the presence of 16 pairs of legs and by the absence of an accessory tooth on the outer blade of the mandible. At the same time it is distinguished from this species by most other characters and resembles *P. leuckartii* * in the following:—1, alternation of tegumentary folds; 2, reduction of the pedal papillæ to three; 3, the relative dimensions of the rings of the soles; 4, the multiplicity of the crural glands; 5, the analogy of the anal glands; 6, a certain resemblance in the unpaired portion of the male gonoduct.

It is, however, different from all other species in the possession of crural glands on the first legs—glands of enormous length. It is supposed to be unique in the constant presence of 16 pairs of legs with 3 papillæ. Its unpaired male duct is supposed to be really like no others. In short, it is supposed to present a mixture of primitive characters with others indicating a long evolution. These may be classified as follows:—

Primitive Characters.	*Advanced Characters.*
1. Crural glands opening on each leg.	1. No teeth on outer blade of mandible.
2. 16 pairs of legs.	2. Pedal papillæ reduced to three.
	3. Seminal receptacles atrophied.
	4. Character of male gonoduct.

I do not consider that we can lay much stress upon affinities which are only indicated by the presence of 16 versns 15 pairs of

* *P. leuckartii* is taken as the correct name for the common Peripatus of the East, usually designated *P. orientalis* by Bouvier. For a discussion on the nomenclature of this species see Dendy (Q. J. M. S. vol. xlv. p. 388, and Zool. Anz. 1906, pp. 175-177).

legs or the presence or absence of an accessory tooth on the outer mandible-blade. Surely some such change as this could have occurred as a mutation over and over again. In any case the West Australian species occurs in two forms, one with 16 and one with 15 pairs of legs, so that the resemblance to *P. suteri* does not hold good.

As a matter of fact *Peripatoides occidentalis* approaches most closely *Peripatoides leuckartii*, and in addition to the resemblances noted by Bouvier we may add that receptacula seminales *are* present in both forms. The species is, however, very distinct from all other Peripatus species, and thus from all the other Australian species (which is not surprising seeing that the two Peripatus regions are separated by over two thousand miles, the greater part of which is country quite uninhabitable by Peripatus) in the presence of extraordinarily long crural glands opening on the first pair of legs. The northern variety is the only known Peripatus in Australia having 16 pairs of legs.

SUMMARY OF RESULTS OF GENERAL IMPORTANCE.

(*i. e.* probably applicable to most if not all species of Onychophora.)

I. The cells of a certain part of the so-called nephridium—that which opens into the terminal cœlomic vesicle—bear long and well-developed cilia. Thus cilia occur in the excretory ducts of Peripatus as well as in the reproductive organs.

II. Crural glands *do* sometimes occur in the female, but do not seem to possess any ducts.

III. The tracheæ of Peripatus possess a characteristic spiral supporting fibre.
(This has been a disputed question for many years.)

IV. The tracheæ of Peripatus, although running a separate course for some distance from the tracheal pit, eventually branch (see Pl. II. figs. 7 & 8).

V. Spermatogenesis does not take place in the testis but in the seminal vesicles. This discovery, made originally by Gaffron, seems to have been lost sight of in most descriptions of Peripatus.

LITERATURE CITED IN TEXT.

1. Balfour.—Anatomy and Development of *Peripatus capensis*. Q. J. M. S. 1883.
2. Bouvier.—Monographie des Onychophores. Ann. des Sci. Nat. (9) 2 & 5. Paris, 1905 & 1907.
3. Bouvier.—Onychophora. Die Fauna Süd-West Australiens, Bd. ii. Lief. 18. Jena, 1909.

4. Dakin.—The Onychophora of West Australia. Proc. Zool. Soc. London, 1914.
5. Dendy.—On the Oviparous Species of Onychophora. Q. J. M. S. vol. xlv. p. 388.
6. Dendy.—Zool. Anz. Bd. xxx. Nr. 6, 1906, pp. 175–177.
7. Fletcher.—On the Specific Identity of the Australian Peripatus, etc. Proc. Linn. Soc. N. S. W. 1895, vol. x.
8. Gaffron.—Zoolog. Beiträge (Schneider). Breslau, 1883.
9. Sedgwick.—Various papers on *Peripatus*. Reprinted in vol. iv. Studies from the Morphological Laboratory of the University of Cambridge. 1889.
10. Sedgwick.—Article on Onychophora in Cambridge Natural History.
11. Sheldon.—Anatomy of *Peripatus capensis*, etc. Q. J. M. S. vol. xxviii. 1888.
12. Baldwin Spencer.—Proc. Roy. Soc. Victoria, vol. xxi. (N. S.) pt. 2, 1909.
13. Willey.—Anatomy and Development of *P. novæ-britanniæ*. Zoological Results. Part I. 1898.

DESCRIPTION OF FIGURES.

Plates I.–V.

Peripatoides occidentalis.

Fig. 1. Dissection, showing slime gland, alimentary canal, and salivary gland. × 5½.
2. Dissection, female, showing reproductive organs and nephridia. × 5½.
3. Dissection, male, showing reproductive organs and crural glands. × 5½.
4. Photomicrograph. Transverse section, showing large seminal vesicle lying above alimentary canal and crural papilla retracted.
5. Longitudinal section. Salivary gland. × 400.
6. Inner face of body-wall in freshly dissected specimen, showing arrangement of main tracheæ. The piece extends across the two ventral nerve-cords, and laterally up one side and beyond the mid-dorsal line. The positions of three legs are shown (N). × 20.
7. Alimentary canal-wall under low power, showing tracheæ branching. × 96.
8. Tracheal branching. × 640.
9. Tracheal tube, showing spiral thickening. × 800.
10. Section through crural gland. × 160.
11. Nephridium in longitudinal section, showing cilia. × 240.
12. Photomicrograph of ciliated part of nephridium.
13. Opening of vas deferens into vesicula seminalis, section to show structure of wall. × 200.
14. Photomicrograph of section through vesicula seminalis, showing spermatozoa and spermatogenesis.
15. Transverse section. First part of vas deferens. × 200.
16. Median part of vas deferens, with mass of spermatozoa. × 200.
17. Terminal thick-walled part of vas deferens. × 200.
18. Longitudinal section. Ductus ejaculatorius. × 200.
19. Diagrammatic transverse section in plane of last pair of legs. × 24.
20. Diagrammatic transverse section in plane where vas deferens crosses below nerve-cords posteriorly. × 24.
21. T. S. Part of wall of anal gland of male. × 240.
22. Diagram showing connections of receptacula seminis with oviducts, and ovaries. × 200.
23. T. S. Infundibular region of oviduct. × 200.
24. L. S. Wall of ovary and oviduct. × 240.
25. T. S. Duct of receptaculum seminis. × 280.

EXPLANATION OF LETTERING.

A.	Anus.
An.Gl.	Anal gland.
Cil.R.	Ciliated portion of nephridium.
Cœ.	Cœlomic cavity.
Coll.Ves.	Collecting vesicle.
Cr.Gl.	Crural gland.
Cr.Gl.′	Crural gland of 1st leg.
Cr.Gl.″	Crural gland of last leg.
Crur.pap.	Crural papilla.
Cut.	Cuticle.
Epid.	Epidermis.
Ht.	Heart.
N.	Position of leg.
N.C.	Nerve cord.
Neph.	Nephridium.
Neph.′	Ditto of 4th and 5th legs.
Or.Pap.	Oral papilla.
Ov.	Ovary.
Ovid.	Oviduct.
Ph.	Pharynx.
Rec.Sem.	Receptaculum seminis.
Rect.	Rectum.
Sal.Gl.	Salivary gland.
Sal.G.d.	Salivary gland duct.
S.V.	Seminal vesicle.
Sli.Gl.	Slime gland.
Sp.	Spermatozoa.
Tes.	Testis.
Ut.	Uterus.
Vag.	Vagina.
Vas.def.	Vas deferens.
Vas.def.r.	Vas deferens of right side.
Vas.def.l.	Ditto of left side.